VALID UNTIL 5/4/07

APPENDIX 4 - TRANSPORT REFRIGERATION UNITS

Below is additional information pertaining to the Transport Refrigeration Unit (TRU) section under AQMD's FY 2007 Carl Moyer Program (CMP). All information in Program Announcement (PA) **PA #2007-08** and this Appendix apply. For additional detail regarding this program category, refer to CARB's 2005 CMP Guidelines. In the case of any conflict between CARB guidelines and AQMD criteria, the more stringent criteria will prevail.

In February 2004 the CARB Board approved an airborne toxic control measure (ATCM) TRU control measure that phases in new in-use standards over the next 12 years. Table 4-1 below lists the new standards and compliance options. In order to qualify for CMP funding, projects need to provide emissions reductions that exceed the ATCM requirements either because they are implemented earlier than required or because the selected compliance option is cleaner than required. Table 4-2 provides information on the time period for surplus emission reductions based on early compliance.

It is the Applicant's responsibility to check with AQMD's CMP web page for program clarifications, changes and updates. This page may be accessed by clicking the link on AQMD's home page at http://www.aqmd.gov/tao/implementation/carl_moyer_program_2001.html.

CARB MOYER PROGRAM RESOURCES

Applicants are highly encouraged to review CARB guidelines for additional requirements of the CMP. CARB guidelines are incorporated into AQMD's Moyer Program by reference. 2005 CARB guidelines may be downloaded from:

http://www.arb.ca.gov/msprog/moyer/guidelines/revisions05.htm

On this web page, there are links to the four parts of the CARB 2005 CMP guidelines. These parts are described below for easy reference.

- Part I provides the Executive Summary, Program Overview and Administrative Requirements primarily applicable to air districts) for CARB's Carl Moyer Program. The link to Part I is

http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part1.pdf

- Part II provides the Project Criteria for each program category. The link to Part II is http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part2.pdf. TRUs are covered in Chapter 4.

- Part III provides the Agricultural Assistance Program guidelines. Link to Part III at http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part3.pdf

- Part IV is the Appendices section of the guidelines. The link to Part IV is http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part4.pdf . This section includes the following Appendices.

    - Appendix A – Acronyms
    - Appendix B – Tables for Emission Reduction and Cost-Effectiveness Calculations—Table B-11 lists TRU engine load factors
    - Appendix C – Cost-Effectiveness Calculation Methodology
    - Appendix D – Example Calculations
    - Appendix E – Description of Certification and Verification Executive Orders
    - Appendix F – Retrofit Emission Control Strategies
    - Appendix G – Description of Functional Equivalency of Non-Original Equipment Manufacturer Repowers and Rebuilt Engines for use in Repowers

HIGHLIGHTS FOR 2007

- The project cost-effectiveness limit is $5,000 per weighed ton of NOx, PM and ROG emissions reduced. A four (4) percent capital recovery factor is used for the cost-effectiveness calculation.

- Cost-effectiveness calculations are based on particulate matter (PM10), oxides of nitrogen (NOx), and reactive organic gases (ROG). The formula is provided below. AQMD staff will calculate the NOx, PM and ROG emissions reductions during the evaluation process.

Annualized Cost ($/year)

NOx reductions + 20(combustion PM10 reductions) + ROG reductions (tons/year)

- Applicants **must** provide current vendor quotes **obtained within the last 90 days**, with their application to document the incremental cost of implementing the proposed technology. This will require documentation of both the baseline and low-emission project costs. Applicants can request funding up to the full differential cost between an optionally certified low-emission vehicle/engine/equipment and its new base standard emission equivalent; however, less may actually be awarded, depending on the results of the cost-effectiveness evaluation.

- Applicants **must** also provide documentation that justifies the activity level projected for the vehicles (i.e., mileage logs, hour-meter records, business records, fuel receipts, etc.) for the past two years.

- All projects must be operational within eighteen (18) months of contract execution or by May 31, 2009, whichever is earlier.

- The new engine/equipment/vehicle must not have been purchased prior to the effective date of the contract.

- AQMD will conduct pre- and post-project inspections of all equipment, as required. Additional reporting and monitoring requirements are discussed below.

- Particulate filters and diesel oxidation catalysts are eligible for funding. These diesel emission control system (DECS) retrofit devices must be verified by CARB. Further, in order to include NOx emission reductions in the cost-effectiveness evaluation, the technology must be verified to reduce NOx emissions by at least 15 percent compared to the original engine certification level.

- The cost of the retrofit, and all filters needed during the project life, may be paid for with Carl Moyer Program funding provided it meets the weighted cost-effectiveness limit.

- If the horsepower rating of the new engine exceeds that of the existing engine by 25 percent or more, the difference in the rating will be taken into account in the emission reduction calculation.

- AQMD reserves the right to disqualify any application that does not comply with all applicable requirements including submission of a complete application package.

- Part One of Attachment 1 of the AQMD Application Form requires that **all** repower and retrofit projects provide the vehicle identification numbers (VINs) for the project vehicles in both hard copy and electronic format. This information will be provided to ARB for an ARB Violation Compliance Check. Any outstanding violations for a project vehicle must be resolved in advance of contract execution.

- Applicants must provide the information necessary to determine the project life time frame during which the emissions are surplus. This includes model year and horsepower of the TRU or TRU Generator Set Engine.

- Pre- and Post-Inspection of all vehicles/engines approved for funding is required as well as verification of engine destruction. Payment will be made only after all inspections are completed and engine/vehicle destruction is verified.

- Please review CARB's CMP Guidelines, Part IV, Appendix E for a comprehensive description of certification Executive Orders for new engines and Verification Letters for retrofit devices.

EVALUATION METHODOLOGY

AQMD staff will evaluate all submitted proposals and make recommendations to the Governing Board for final selection of project(s) to be funded. Proposals will be evaluated based on the cost-effectiveness of emissions (NOx + ROG + 20*PM) reduced on an equipment-by-equipment basis, as well as a project's "disproportionate impact" evaluation (discussed below). Be aware of the possibility that due to program priorities and/or funding limitations, project applicants may be offered only partial funding, and not all proposals that meet minimum cost-effectiveness criteria may be funded.

In compliance with AB 1390, Firebaugh, the FY 2007 CMP requires that at least 50 percent of the funds be spent in areas that are disproportionately impacted by air pollution. CARB has issued broad goals and left the details of how to implement this requirement to each air agency. In the South Coast Air Quality Management District, the disproportionately impacted areas are defined by a weighted formula that includes poverty level, particulate matter (PM) exposure and toxic exposure. The process is described below:

1. All projects must qualify for the CMP by meeting the cost-effectiveness limits established in the PA.

2. All projects will be evaluated according to the following criteria to qualify for Disproportionate Impact funding:

    a. Poverty Level: All projects in areas where at least 10 percent of the population falls below the Federal poverty level based on the year 2000 census data, will be eligible to be included in this category, and

    b. PM Exposure: All projects in areas with the highest 15 percent of PM concentration will be eligible to be ranked in this category. The highest 15 percent of PM concentration is 46 micrograms per cubic meter and above, on an annual average, or

    c. Toxic Exposure: All projects listed in the Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II) report[1] as having a cancer risk of 1,000 in a million and above will be eligible to be ranked in this category.

    Data for the poverty level and PM and toxic exposures were obtained from the U.S. Census, the 1998 AQMD monitoring data and Mates II study respectively.

3. Fifty percent of the funding available for this **PA (#2007-08)** will be allocated among proposals located in disproportionately impacted areas. If the funding for disproportionately impacted areas is not exhausted with the outlined methodology, then staff will return to the Governing Board for direction. If funding requests exceed 50 percent of the total available funding, then all qualified projects will be ranked based on their disproportionate impact. Each project will be assigned a score that is comprised of 40 percent for poverty level, and 30 percent each for PM and toxic exposures. Proposals with the highest scores will receive funding until 50 percent of the total funding is allocated.

    All the proposals not awarded under the fifty percent disproportionate impact funding analysis will then be ranked according to cost-effectiveness, with the most cost-effective project funded first and then in descending order for each funding category until the remainder of the Moyer Funds are exhausted. Some projects that exceed the cost-effectiveness ceiling may receive partial funding, depending on their rankings.

[1] Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II), SCAQMD, March 2000.

ELIGIBLE COSTS

Eligible project costs (i.e., costs for which Moyer funding is requested) are limited to the incremental cost of a project to implement the reduced emission technology. Operation and maintenance costs are not eligible for CMP funding. Please refer to the Project Types section below for additional detail.

REPORTING AND MONITORING

All participants in the CMP are required to keep appropriate records during the full contract period. Project life is the number of years used to determine the cost-effectiveness and is equivalent to the contract life. All equipment must operate in the AQMD for this full project life. Annual records must contain, at a minimum, total California hours idled. Records must be retained and updated throughout the project life and made available for AQMD inspection. The AQMD may conduct periodic reviews of each vehicle/equipment project's operating records to ensure that the vehicle is operated as stated in the program application.

COST-EFFECTIVENESS EVALUATION DISCUSSION

Cost-effectiveness calculations are based on particulate matter (PM10), oxides of nitrogen (NOx), and reactive organic gases (ROG). AQMD staff will calculate the NOx, PM and ROG emissions reductions during the evaluation process. Only CMP funds are to be used in determining cost-effectiveness[2]. The one-time incentive grant amount is to be amortized over the project life (which is also the contract term) at a discount rate of 4 percent. The amortization formula (given below) yields a capital recovery factor (CRF), which, when multiplied by the initial capital cost, gives the annual cost of a project over its project term.

$$CRF = [(1 + i)^n (i)] / [(1 + i)^n - 1]$$

where

i = discount rate (4 percent)
n = project life (at least 3 years)

Table 4.1 lists the CRF for different project lives using a discount rate of 4 percent. Cost-effectiveness is determined by dividing the annualized costs of a project by the annual weighted emission reductions offered by the project.

[2] Unless the AQMD "buys down" the cost of the project by adding additional funding, in which case the total grant funding amount should be used for the cost-effectiveness calculation.

Table 4.1 – Capital Recovery Factors (CRF) for Various Project Lives At 4 Percent Discount Rate

Project Life	CRF
3	0.360
4	0.275
5	0.225
6	0.191
7	0.167
8	0.149
9	0.134
10	0.123
11	0.114
12	0.107
13	0.100
14	0.095
15	0.090
16	0.086
17	0.082
18	0.079
19	0.076
20	0.074

Below are excerpts[3] from CARB's CMP Guidelines (Chapter 4 – Transport Refrigeration Units) pertinent to the AQMD PA.

I. Introduction

TRUs are employed in service carrying perishable goods throughout the world. TRUs use an internal combustion engine to run the compressor of the refrigeration system. TRUs and TRU generator sets operating in the United States are generally powered by diesel engines, typically between 9 and 36 horsepower. TRUs may be installed on trucks, trailers, shipping containers, and railcars to refrigerate perishable contents. TRU generator sets are also attached to ocean-going shipping containers when they are on land, to provide electric power to the shipping container's refrigeration system between the port and cold storage warehouse or distribution center.

II. Emissions

The Air Resources Board (ARB or "Board") estimates that emissions of diesel particulate emissions from TRUs and TRU generator sets were almost two tons per day or 2.6 percent of the total statewide diesel particulate matter emissions in 2000. Estimated NOx emissions in 2000 were about 20 tons per day. Based on emission projections, the diesel PM10 emissions from TRUs will decrease to about 1.6 tons per day in 2010 and decrease again to about 0.3 tons per day in 2020, because of the cumulative effects of new emission standards and ARB's

[3] The information below is excerpted from CARB's 2005 CMP Guidelines. Not all sections of the guidelines were pasted here, but CARB numbering was retained to stay consistent with CARB Guidelines for easy cross-reference.

in-use TRU Airborne Toxic Control Measure (ATCM).

III. Regulatory Requirements

In February 2004, the Board approved an airborne toxic control measure (ATCM) for TRUs that set in-use performance standards for PM10 emissions beginning in 2008. Compliance is phased in over the next 12 years.

The TRU ATCM In-Use Performance Standards and compliance dates must be considered when determining whether emission reductions are surplus. Table 4-1 gives the TRU and TRU Generator Set In-Use Performance Standards and Table 4-2 provides a graphical representation of the implementation schedule. The region in Table 4-2 labeled Potential Surplus Reductions shows a window of opportunity where projects can achieve emissions reductions prior to the compliance date of the TRU ATCM [ARB, 2003].

Table 4-1
TRU and TRU Generator Set In-Use Performance Standards

Horsepower Category	Engine Certification Value PM10 Emissions Standard (grams/horsepower-hour)	Options for Meeting Performance Standard
Low Emission Performance Standards		
less than 25	0.30 g/hp-hr	▪ Use an engine that meets the Engine Certification Value ▪ Retrofit with at least Level 2 DECS* (>50% PM10 reduction) ▪ Use an Alternative Technology
25 or greater	0.22 g/hp-hr	▪ Use an engine that meets the Engine Certification Value ▪ Retrofit with at least Level 2 DECS ▪ Use an Alternative Technology
Ultra-Low Emission Performance Standard		
less than 25	N/A	▪ Retrofit with Level 3 DECS (>85% PM10 reduction) ▪ Use an Alternative Technology
25 or greater	0.02 g/hp-hr	▪ Use an engine that meets the Engine Certification Value ▪ Retrofit with Level 3 DECS ▪ Use an Alternative Technology

* Diesel Emission Control System

Table 4-2

25 hp TRU and TRU Generator Set Engines In-Use Compliance Dates
(Compliance date is December 31 of applicable year)

MY	In-Use Compliance Year													
	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
'01 & Older		L	L	L	L	L	L	L	U	U	U	U	U	U
'02			L	L	L	L	L	L	L	U	U	U	U	U
'03				U	U	U	U	U	U	U	U	U	U	U
'04	Potential				U	U	U	U	U	U	U	U	U	U
'05	Surplus					U	U	U	U	U	U	U	U	U
'06	Emissions						U	U	U	U	U	U	U	U
'07								U	U	U	U	U	U	U
'08									U	U	U	U	U	U
'09										U	U	U	U	U
'10											U	U	U	U
'11												U	U	U
'12													U	U
'13														

< 25 Hp 2013 and subsequent MY must meet ULETRU 7 years after MY L = Low-Emission TRU, U = Ultra Low-Emission TRU

IV. Potential Projects

TRU owners can apply for Carl Moyer Program grant funds for projects that achieve surplus emission reductions by repowering with cleaner certified engines, installing verified retrofit diesel emission control strategies, or using alternative technologies to reduce or eliminate NOx, ROG, and PM10 emissions. Many of the technologies discussed below have not yet been verified. However, they are included in this discussion since they could provide real emission reductions and could potentially be verified during the time frame covered by the Guidelines.

A. New Purchase

Purchase of a new TRU is eligible for Carl Moyer Program funding if the new TRU is cleaner than what would have normally been purchased – a diesel engine. Thus the incremental cost of the new purchase of alternative technologies may be eligible for Carl Moyer Program grants.

B. Repower

Repowering TRUs with cleaner certified diesel engines is one type of potential project. However, there may be some compatibility issues with some engines due to spatial and electronic control differences (e.g., the new engine is too big to fit in the available space or the electronic controls are incompatible). Those compatibility issues must be resolved prior to submitting a grant application.

C. Retrofit with a Diesel Emission Control Strategy

Retrofit with a diesel emission control strategy is another potential project if the retrofit is not required by the TRU ATCM or any other regulation. Diesel retrofit systems must be verified by ARB in order to qualify for Carl Moyer Program funding. Potential retrofits include diesel oxidation catalysts, diesel particulate filters, flow though filters and fuel additives.

D. Alternative Technologies to Reduce or Eliminate NOx, ROG, and PM Emissions

Alternative technologies are defined under the TRU ATCM as electric standby, cryogenic temperature control systems, alternative fuels, alternative diesel fuels, fuel cells, and other systems that reduce or eliminate diesel engine operation. Brief descriptions of each of these potential project types follow.

1. Electric Standby

Electric standby equipped TRUs allow the TRU engine to be shut off when a compatible electric power supply is available at a facility so TRU diesel engine emissions are eliminated while the TRU is plugged in at the facility. Electric standby transportation refrigeration units allow the engine to be turned off when a compatible electric power supply is available to operate the transportation refrigeration unit (TRU). Diesel engine emissions are eliminated while the TRU is plugged in at the facility. TRU manufacturers currently offer an electric standby option on most models but very few trucks operating in the United States – less than one percent of trucks with TRUs – opt for these units. This technology does not reduce emissions when the vehicle is away from an electricity source.

Electrically-driven TRUs could, in the long term, be powered by fuel cells. This would allow the TRU to operate emission-free while enroute or when stopped at a facility, regardless of the availability of electricity. As previously mentioned, fuel cell technology for this application is not currently market-ready.

ARB is proposing to evaluate zero-emission TRU projects on a case-by-case basis.

2. Hybrid Electric TRU

Hybrid electric TRUs have been available in Europe for several years. The diesel engine drives a generator that, in turn, powers an electric semi-hermetic refrigeration compressor and electrically driven fans, all controlled by an advanced microprocessor. This hybrid electric TRU is easily adaptable to run on electric grid power when at a facility, so that diesel engine operation is

eliminated. The cost is higher than a traditional TRU, but costs less than it would to retrofit a traditional TRU with an electric standby system. One big advantage is that the hybrid design provides full refrigeration capacity for the initial chill-down. The hybrid design is also very likely to be adaptable for future use with fuel cell technology

3. Cryogenic Temperature Control Systems

Cryogenic temperature control systems heat and cool using a cryogen, such as liquid carbon dioxide or liquid nitrogen that is routed through an evaporator coil that cools air blown over the coil. Since there is no diesel engine, diesel PM10 emissions are eliminated. Capital costs for these types of systems are ten percent higher than a diesel TRU, but the facility infrastructure costs for cryogenic "fuel" storage and dispensing add to the capital cost.

4. Alternative Fuels

Conventional diesel engines are internal combustion, compression-ignition engines. In contrast, engines that operate on an alternative fuel, such as compressed natural gas (CNG), liquefied natural gas (LNG), and liquid propane gas (LPG), are usually spark-ignited. Engines certified to operate on alternative fuels produce substantially lower PM10 and NOx emissions than diesel-fueled engines that are not equipped with exhaust after-treatment.

5. Alternative Diesel Fuels

Before any alternative diesel fuel can be used to comply with a diesel PM10 control measure or used in a Carl Moyer Program project, it must be verified through ARB’s Verification Procedure, which includes a special section that deals specifically with alternative diesel fuels.

The Carl Moyer Program does not fund fuel-only projects however, districts may use matching funds to pay for the incremental cost of alternative diesel fuels if they are part of a Carl Moyer Program project. Recordkeeping and reporting must provide assurance that the emission reductions are real, quantifiable, surplus and enforceable.

6. Fuel Cells

Compared to a conventional diesel-powered TRU, fuel cell TRUs would offer zero or near-zero emissions of criteria pollutants and lower greenhouse gas emissions. At this time, there are no fuel cells appropriately sized for use on a TRU, but electrically-driven TRUs could be powered by fuel cells on or off the road (e.g., at a facility).

V. Proposed Project Criteria

Participating districts retain the authority to impose additional more stringent requirements in order to address local issues.

A. General Criteria

- Emission reductions obtained through Carl Moyer Program projects must not be required by any federal, state or local regulation, memorandum of

agreement/understanding, settlement agreement, mitigation requirement, or other legally binding document.

- Projects must meet a cost-effectiveness of $5,000 per weighed ton of NOx + ROG + combustion PM10 reduced calculated in accordance with the cost-effectiveness methodology discussed in this chapter.
- No emission reductions generated by the Carl Moyer Program shall be used as marketable emission reduction credits, or to satisfy any emission reduction obligation of any person or entity.
- No project funded by the Carl Moyer Program shall be used for credit under any federal or state emission averaging, banking, and trading program.
- Carl Moyer Program grants shall be no greater than a project's incremental cost. The incremental cost is the cost of the project minus the baseline cost. The incremental cost shall be reduced by the value of any current financial incentive that reduces the project price, including but not limited to tax credits or deductions, grants, or other public financial assistance.
- Projects must have a minimum project life of three years. ARB may approve shorter project life in writing for good cause on a case-by-case basis. Projects with shorter lives may be subject to additional funding restrictions, such as a lower cost-effectiveness limit or a project cost cap.
- The contract term is equivalent to the project life used to evaluate cost-effectiveness.
- The default project life does not consider upcoming regulatory requirements. Project life may be shorter due to regulatory requirements.
- Air districts must consult with ARB staff to determine eligibility of all projects considered for funding on case-by-case basis. All projects considered on a case-by-case basis must receive ARB approval prior to receiving program funding.
- Emission benefits must be based on the TRU operations that occur in the South Coast Air Basin. 75 percent of TRU operations must be in the South Coast Air Basin. The ARB may approve exceptions in writing on a case-by-case basis.
- Air districts are encouraged to co-fund projects that will produce emission reductions in more than one air district. (Most TRU projects will provide multi-district emission reductions.)

B. Repowers

- For repower projects, Carl Moyer Program funds shall only be used to pay for the incremental costs of an eligible engine and the cost to install that engine in the TRU equipment.
- The replacement engine for repower projects used in the TRU must meet

current emission standards and be certified by the ARB for sale in California. Compliance with all applicable durability and warranty requirements is required.

- Repower projects must provide at least 15 percent NOx emission benefit compared to baseline NOx emission level.
- The participant shall install an hour-meter or other means to measure usage on the TRU to track operating hours, and shall provide this information to ARB or the district upon request.
- Potential projects that fall outside of these criteria may be considered on a case-by-case basis is evidence provided to the air district suggests potential surplus, real, quantifiable and enforceable emission reduction benefits.
- Air districts must consult with ARB staff to determine eligibility of all projects considered for funding on a case-by-case basis. All projects considered on a case-by-case basis must receive ARB approval prior to receiving program funding.

C. Retrofits

- For retrofit projects, diesel emission control strategies used on TRUs must be verified by ARB for sale in California. Compliance with all applicable durability and warranty requirements is required.
- Alternative Technologies such as electric standby and pure cryogenic systems are not required to be verified, but ARB must review and approve such systems in writing on a case-by-case basis. The district shall require recordkeeping and reporting to assure that estimated emission reductions are achieved.

D. Scrap

- Scrap requirements are described in the 2005 Carl Moyer Program Guidelines, Part I, Chapter 2: Administration of the Carl Moyer Program.

VI. Cost-Effectiveness

To receive Carl Moyer Program funding, each project must meet the maximum cost-effective threshold of $5,000 per weighted ton of covered pollutants reduced. Only funds provided by the Carl Moyer Program and local district matching funds are to be used in determining cost-effectiveness.

In general, the emission reduction benefit represents the difference in the emission level of a baseline engine and reduced-emission engine, retrofit, or use of alternative technology. TRU engine annual emissions are calculated by multiplying the emission factor in grams per horsepower-hour for each pollutant by the rated hp, load factor, and activity (annual engine hours of operation).